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Technological analysis of the Acheulian assemblage from Atbarapur in the Siwalik Range (Hoshiarpur District, Punjab)

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Abstract
The largest collection of Acheulian artefacts in the Siwalik region of the Indian sub-continent is from the site of Atbarapur in the Hosiarpur district of Punjab. It is not dated but recent synthesis of the palaeomagnetic and palaeontolgical data from the Siwaliks shows that some Upper Siwalik sediments are younger than the Olduvai event but in any case older than 0.6 Ma. The artefacts from Atbarpur are probably derived from such sediments, then providing a minimum age for this industry. In spite of its derived nature the assemblage is homogenous and its technological study leads to a better understanding of the character of the Acheulian in this region. Two "*chaînes opératoires*" have been identified, both are similar: short and simple. One was oriented to the production of small flakes, and the second to the production of large flakes. The handaxes and cleavers, typical of the Acheulian, were mostly made on the large flakes often struck from larger flakes (Kombewa method) or from split boulders.

Key words: Acheulian, Siwaliks, Pinjore, large flake, handaxe, cleaver.

1. Introduction

In the north-western region of the Indian sub-continent two Palaeolithic industries were identified in the 1930's: the Soanian, named after the Soan river draining the Potwar Plateau (Pakistan) and the Acheulian (de Terra and Paterson 1939, Teilhard de Chardin 1935, 1936, Teilhard de Chardin and de Terra 1936). Soanian assemblages (mainly composed of cobble tools, and flakes) are the most common and occur in numerous sites located on the river terraces or on the divides and plateaus in between as well as in the intermontane valleys ("duns") formed by the uplift of Siwaliks. The Acheulian is much less common than the Soanian and is usually represented by small numbers of cleavers or handaxes, often only single pieces, from any one locality (de Terra and Paterson 1939, Mohapatra 1981, Mohapatra and Singh 1979, Rendell and Dennell 1985, Chauhan 2003).

Movius (1944, 1948), considered the presence of Acheulian artefacts insignificant in the Siwaliks, and emphasised the Soanian cobble tools in his theory of two cultural zones during the Lower Palaeolithic in the Old World, leading to the concept of a "Movius line". This concept is still being debated (Keates 2002, Corvinus 2004), although in Eastern Asia there are now strong arguments against it with the presence of handaxes or cleavers in south China (Huang 1989, Hou *et al.* 2000), in Korea (Norton et al. 2006) in Sumatra (Forestier et al. 2005) and in Java (von Koeningswald 1936, Lumley *et al* 1993, Sémah *et al*. 2003). In the

Siwaliks also, the large number of Acheulian finds, and the strong suggestion that the Acheulian sites pre-date the Soanian, throws the concept of separate lower Palaeolithic traditions into doubt. The Movius line however, was more or less accepted in India until the end of the1970's, given the only evidence of Soanian sites (Lal 1956, Mohapatra 1966, Pruffer 1956, Sen 1955). But since 1975 Acheulian artefacts from several localities in the Indian Siwalik Range have been discovered (Mohapatra 1975, 1981 Mohapatra & Singh 1979a, 1979b).

Mohapatra always rejected the idea that the Acheulian implements were originating from the underlying Upper Siwalik sediments as he considered them to be much older than the possible age for the Acheulian. However since the 1980's not only has the dating of Acheulian become older (1.2 Myr at Isampur in peninsular India; Blackwell *et al*. 2001; Paddayya *et al*. 2002; Lower Pleistocene at several sites; Sangode et al 2007), but also some formations of the Upper Siwalik sub-group have been shown to be younger than others (Opdyke *et al.* 1979). Recently, Nanda (2002) has reviewed the fauna of the Upper Siwaliks, called Pinjore in India, and has identified two localities - Paramal-Uttarbeni near Jammu and Patiali Rao, near Chandigarh - where fossil yielding Siwalik sediments younger than the Olduvai event occur. He dates the end of sedimentation at these two localities at around 0.6 myr. The occurrence of "Acheulian" artefacts in sediments between 1 million and half a million years old is quite possible.

A better knowledge of the assemblages considered Acheulian in the Siwaliks is of first importance. In the entire Siwalik range, from the Indus to the Brahmaputra, Atbarapur (also spelled Atvarpur or Aitbarapur) is the only site known so far, where more than 50 typical Acheulian artefacts have been found, along with flakes, cobble tools and cores. Although not accurately dated, this site provides interesting technical data for further comparisons between western, eastern and southern Asia.

The assemblage studied in this paper was collected in the 1980's by the two Indian authors during their field work in the Hoshiarpur Siwalik Range (fig. 1). Several publications have described the lithic artefacts and their setting (Mohapatra 1981, Kumar and Rishi 1986, Rishi 1989). This study aims at providing more details on their technology in order to characterise the Acheulian technical tradition in the Siwaliks.

2. Geographical, geological and chronological contexts

Atbarapur is located about 25 km north of Hoshiarpur, which is the chief town of the district. The north-eastern sector of this region is occupied by the Siwaliks, which represent both geological formations and geomorphological features. The Siwalik sediments, ranging in age from around 18 Ma to Middle Pleistocene and resulting from the erosion of the Himalayas, occur right from Pakistan in the west to Bhutan in the east. They have been finally uplifted in the most recent phase of Himalayan orogeny, in the middle of the Middle Pleistocene, and they form a hill range in-between the Himalayan Mountains and the Indo-gangetic plains. With the uplift, faulting processes separated the Siwalik range from the Lesser Himalayas by a long intermontane depression locally called "dun" and drained by different rivers. The sediments of these dun valleys and the terraces of the antecedent rivers flowing from the Himalayas into the Indo-Gangetic plain, postdate the uplift of the Siwalik sediments. Therefore the occurrence of Soanian in the dun valleys and terraces while the Acheulian is found in the areas of Upper Siwalik sediment exposure is most probably due to an older age for the Acheulian compared to the Soanian.

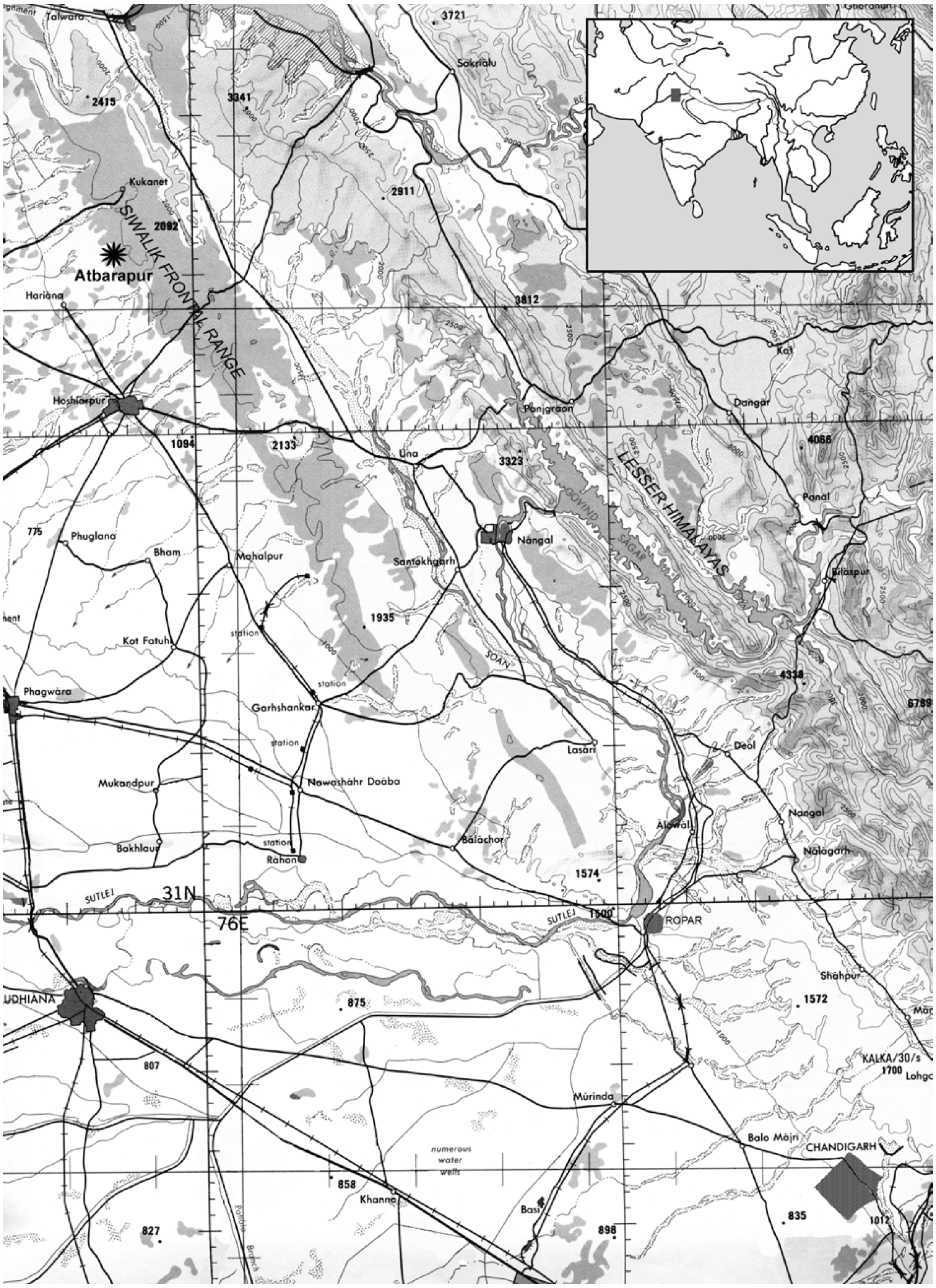

Figure 1. Map of the Hoshiarpur Siwalik Range showing the location of Atbarapur

Mohapatra (1981) first suggested that the Acheulian was only found on outcrops of Upper Siwalik sediments or in the deposits of young streams eroding Upper Siwalik sediments. Following Mohapatra, further discoveries of Acheulian artefacts from areas where Siwalik sediments are exposed were reported (Corvinus 1990, 1995a, 1995b, 2007, Rendell and Dennell 1985, Singh *et al.* 1998). In reviewing the Indian Lower Palaeolithic, Gaillard and Mishra (2001) argued, based on the observations of Mohapatra and others, that the

Acheulian and Soanian were not contemporary Lower Palaeolithic industries, since reported finds of Acheulian came only from areas were older sediments of the Siwalik formation were exposed.

This older age was already observed by the first investigators in the Potwar plateau (Teilhard de Chardin 1936, Teilhard de Chardin and de Terra 1936) and then confirmed by Rendell and Dennell (1985) for two sites, Dina and Jalapur on the Jhelum river where handaxes were found in tilted sediments, and so pre-dated the tilting estimated to have occurred before 400 kyr. Corvinus (1990, 2007) found 12 bifaces from the site of Satpati, in tilted sediments in Nepal, which she also inferred predate the last phase of Himalayan tectonics. The only Acheulian site in the Siwaliks from a post uplift context is Gadari, in the Dang dun valley of Nepal, where two handaxes were found overlying Middle Siwalik bedrock and overlain by Late Pleistocene colluvial silt. Rapid erosion of the silt seen presently makes it likely that these handaxes might have been derived from an earlier episode of sedimentation.

Atbarapur is in the piedmont zone of the sub-Himalayas, at the foothills of the Siwaliks facing the Indo-Gangetic plains (fig. 1). The local outcrops are made of sandstones and loose conglomerates of mostly quartzite pebbles, cobbles and boulders probably belonging to the Pinjore Formation (GSI 1976). The artefacts occur in the choes (seasonal streams) and gullies. The neighbouring villages of Rehmanpur and Takhani have also yielded some Acheulian implements, but the Doonge Tote Wali choe, near Atbarapur, is the richest. Unfortunately (for archaeologists) the construction of a dam has now partly filled up the choe with silty-sandy deposits and significantly modified the local landscape. This choe starts in the Siwalik Hills and flows towards the Punjab plains; its course is of about 1.6 km. It is bordered by terraces on both sides just before it leaves the Siwaliks. The surface of these terraces is covered by thick vegetation of thorny shrubs and grass. At certain places the exposed stratigraphy of the terrace deposits is about 2.5 m thick and consists of 1.5 m of gravel at the bottom, covered by 1 m of loose silt and sand. From the gravel, a few cleavers and choppers were discovered *in situ* but most of the lithic artefacts were found lying on the surface.

3. Composition of the assemblage from Atbarapur

The assemblage from Atbarapur is characterized by a majority of typical Acheulian tools, *i. e.* handaxes and cleavers (table 1). Even if their relative quantity to the total collection has no statistical significance (sample sorted through natural processes), their proportion relative to each other may be more reliable and it is worth noting that the number of cleavers are much more than the handaxes (37 and 15 respectively). Besides these Acheulian tools, made on large flakes, there are only a few other tools on flakes: 2 knives (large backed scrapers), one scraper and one denticulate. Unretouched flakes represent a small group (10). The choppers, made on both flakes and cobbles, are as frequently represented as the cores, usually on cobbles (13 of each).

All these artefacts are in medium to fine grained quartzite, rather dark in colour (red, green, grey). In the Siwaliks, dark coloured quartzites are more metamorphised, silicified and homogenous than the light coloured ones and they were selected by prehistoric people for making their tools, *i.e.* Acheulian as well as Soanian. These rocks were available in the form of cobbles and boulders, as it can be inferred from the patches of cortex remaining on the artefacts. At present, no such large rounded stones are visible at Atbarapur but they are reported in the surroundings.

	number	percentage
hand-axes	15	16%
cleavers	37	40%
knives	2	2%
scraper	1	1%
denticulate	1	1%
unmodified flakes	10	11%
choppers	13	14%
cores	13	14%
	92	100%

Table 1 – Composition of the assemblage from Atbarapur

		Length (mm)	Breadth (mm)	Thickness (mm)
Hand-axes (15-3=12)	mean	140	90	45
	s. d.	43	19	12
Cleavers (37)	mean	145	96	44
	s. d.	21	15	9
Other tools on flakes (4)	mean	126	83	41
	s. d.	30	18	19
Unretouched flakes (10)	mean	150	116	46
	s. d.	40	25	13
Choppers (13)	mean	114	109	54
	s. d.	18	38	14
Cores (13)	mean	116	95	73
	s. d.	25	17	14

Table 2 – Dimensions, according to the morphological orientation, of the different categories of artefacts from Atbarapur (mean and standard deviation)

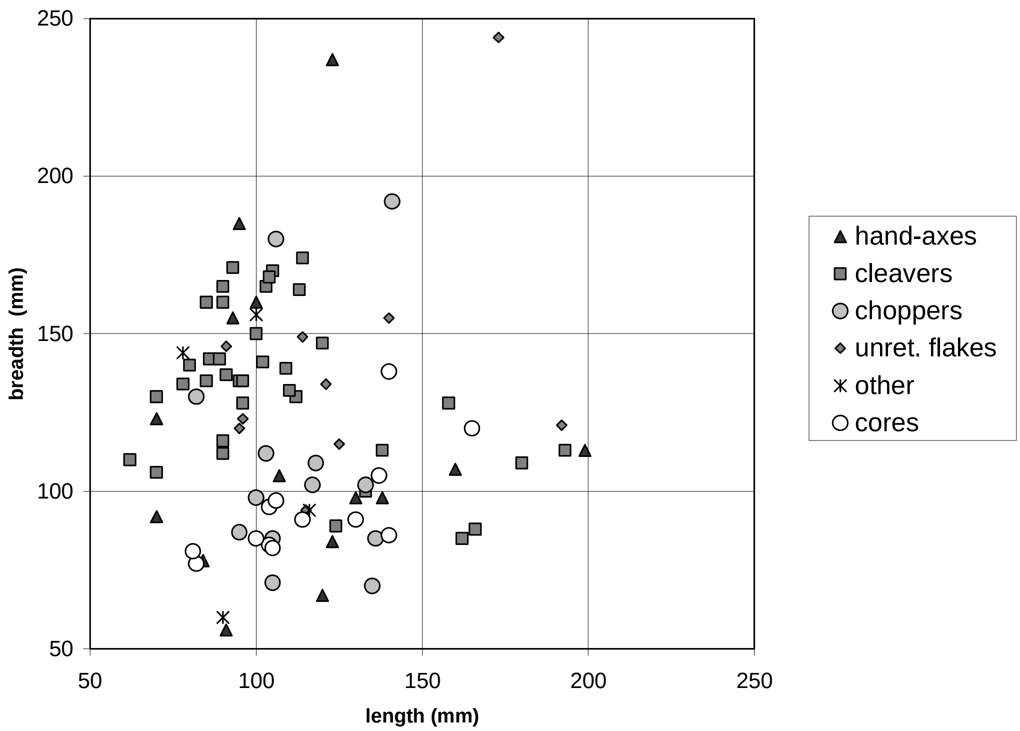

Figure 2. Bidimensional diagram for length and breadth of the artefacts from Atbarapur according to their technical orientation

The Atbarapur assemblage is quite homogenous, as far as the size is concerned (table 2) and this strongly suggests sorting according to size or weight, either due to some taphonomic process or due to anthropic process, resulting in a particular configuration of the original site. Large cores ("giant cores") expected to have produced the majority of the flakes are missing and the smaller flakes, produced by the cores and choppers of the assemblage are also missing. It is to be noted that the morphological measurements given in table 2 do not consider the technological orientation of the artefacts (length = maximal dimension, breadth = maximal measurement perpendicular to the length): for the side struck flakes, the morphological length and breadth are inverted with the technological length and breadth. In this assemblage the longer tools are the handaxes and cleavers, as well as the unretouched flakes, while, with the exception of a few, the choppers and cores are shorter but thicker. Measurements taken with the technical orientation provide the same picture of dimensional homogeneity (fig. 2).

4. Core reduction sequence

4.1. Flakes

In this collection of 92 items, 69 are primarily flakes, mostly retouched (85%), while the others are cobbles, often broken before flaking. One artefact may be made on a slab.

The large majority of the flakes (53/69, about 75%) are side struck or square (no distinction between side struck and end struck) and the end struck flakes are fewer in number (10/69) suggesting a particular way of flaking (6 flakes are undetermined due to extensive trimming). The average maximal dimensions of both types of flake however do not differ much (141 mm and 136 mm; table 3).

		Length (mm)	Breadth (mm)	Thickness (mm)
All flakes (69)	mean	107	130	45
	s. d.	42	35	11
Side struck flakes (53)	mean	104	141	46
	s. d.	29	31	12
End struck flakes (10)	mean	136	99	44
	s. d.	32	22	11

Table 3 – Dimensions of the flakes from Atbarapur, according to their technical orientation (mean and standard deviation)

Striking platforms are fully cortical for more than the half of the identifiable specimens (28/50, excluding the 19 undetermined); while the others are usually completely devoid of cortex (13 have plain and 7 have dihedral platforms) and only rarely partly cortical (2 dihedral platforms).

Usually the percussion point appears in the middle of the ridge between the striking platform and the flaking surface (34) but sometimes it is in the angle (15) or in between the middle and one of the angles (8); others are undetermined. This indicates that quite often the percussion was applied near the corner of the face used as striking platform; and that the flakes were removed along the border of the exploited surface. This method of striking would mostly produce "*débordant*" flakes with a back, which hardly needed to be worked for making a cleaver. Apparently there is no link between the position of the percussion point and the flake morphological elongation.

The dorsal face of the flakes is entirely cortical in a number of cases (20/69). When the striking platform is also cortical (9/20) it indicates that the flakes were the first to be detached from the boulders or cobbles that were selected as cores. When the platform is not cortical (only 2/20, the other ones being undetermined) the stroke was applied on a previous flake scar or fracture. Besides these entirely cortical ones, only a few flakes show a cortical zone extending on more than the half of the dorsal face (6/69) or slightly less than the half (4/69). Many flakes (15/69) only bear small patches of cortex that is less than one fourth of the dorsal face or, more often, that forms a cortical back (steep side). Most of the flakes have no cortex at all (23/69).

A number of these flakes with no cortex or with very little cortex are Kombewa flakes (16/69), in a broad sense, *i.e.* struck from the ventral face of a larger flake or from the flat surface of a split boulder, both being often confusing since the ventral face of the flakes is usually almost flat with a diffuse bulb. For half of them (7) the percussion was in the same direction as the one having produced the larger flake-core; only 2 are perpendicular (others undetermined).

Most of the flakes show 1 previous flake scar (13 ordinary flakes and 4 Kombewa flakes) or 2 scars (8 ordinary flakes and 1 Kombewa). Only a few bear 3 to 5 previous flake scars (table. 4), suggesting that they were struck from a core that had already produced several flakes. Since the previous scars (representing the flakes previously removed from the core) are few, the flakes of the Atbarapur assemblage seem to correspond to the beginning of the core reduction sequence; but it must be kept in mind that the later scars can hide some of the earlier ones.

extent of cortex	**Number of flake scars**							
	0	**1**	**2**	**3**	**4**	**5**	**undet.**	**Total**
no cortex	6K	4+2K	5+1K	1	1		3	14+9K
< 1/4	5K	3+2K	1	1	1	1	1	8+7K
1/4 to 1/2		3	1					4
1/2 to 3/4		3	1	1			1	6
fully cortical	20						1	21
Total	20+11K	13+4K	8+1K	3	2	1	6	53+16K

Table 4 – Number of flake scars versus extent of cortex on the dorsal face of the flakes from Atbarapur (ordinary flakes + Kombewa flakes marked "K")

The flakes are relatively large in size. They may well have been produced at the beginning of the reduction sequence and later on, when the cores, more exploited, were getting smaller, the flakes would also have been reduced in size. This part of the sequence, producing smaller flakes, is absent at Atbarapur. Either such flakes were never produced at the original living site and/or workshop, or they are missing due to removal by some taphonomic factor.

The pattern of the flake scars is visible on 26 flakes only. On many of them, the scars show the same flaking direction as the considered flake (11) indicating that the same striking platform was used for all the removals. Sometimes the direction of all the scars is perpendicular (5) or opposite (2) to the flaking direction of the flake itself. When the scars have different directions, they can be perpendicular to each other (4) or opposite (2) or "crossed" with more than two directions (2). This suggests that different faces of the core were used as striking platforms; but there is no proper convergent flaking linked to definite control of the flaking surface convexity.

These debitage products (flakes) appear to result from a rather simple core reduction sequence. The first flakes represent at least 1/8 of the products and slightly more than 1/6 of the non Kombewa products. Therefore, if the Atbarapur assemblage was a good random sample, statistically representative of the production at the original site, this would suggests that each cobble or boulder core had provided 6 or 7 flakes. According to the observed proportions, these 6 or 7 flakes would include 1 first flake, 1 or 2 flakes with a largely cortical dorsal face, 2 or 3 flakes with a small patch of cortex and 2 flakes without cortex. Such a combination fits well with the pattern of a short sequence of production, which is also the production of large size items. It seems quite possible that the collection from Atbarapur may actually be representative of the large sized debitage, that was originally produced during the first stages of the core reduction sequence from boulders in order to acquire large flakes.

The specificity of this debitage is the high proportion of side struck flakes, which may indicate that no attention was paid to the longitudinal convexity. But this is also a simple and convenient method for obtaining a wide cleaver cutting edge, on the lateral side of the flake, formed by the previous removal from the same striking platform (unipolar exploitation of the core). The percussion point at the angle of the flakes, for 1/4 of them, remains to be understood through more detailed observation and experimentation; it may just be the continuation of the same process up to the end of the striking platform. The use of the ventral face of a larger flake (Kombewa method) or of the split surface of a boulder as flaking surface (1/4 of the production), may be advantageous for getting large cutting edges. Therefore, although simple, the core reduction sequence was oriented and adapted to the production of blanks for manufacturing cleavers.

4.2. Cores

A first look at the 13 cores of the Atbarapur assemblage clearly shows that they have nothing to do with the flakes described above. All of them still bear some patches of cortex attesting that they are river cobbles or boulders. A few of them (at least 4) keep enough of their original shape and volume to show that they actually were cobbles (6 to 25 cm) rather than boulders (> 25 cm). As for the other ones, the convexity of the cortex remnants suggests that they were probably cobbles too. Moreover as their dimensions are smaller than the flake dimensions (tables 2 and 3), it is clear that none of these cores were used for the production of the flakes of the Atbarapur assemblage. They correspond to another production sequence, oriented towards smaller flakes that are unfortunately missing here, probably due to sorting during the process of redeposition.

It seems that some of these cobbles have been intentionally split into two parts before being turned into cores as they show remnants of flat or slightly convex surfaces in between the concave removals. A few of them may be flakes proper, turned into Kombewa cores but the removals hinder us from knowing whether the flaked surface was a proper bulbar ventral face or just a split surface.

The exploitation of these cores is organised into two surfaces showing a large range of convexities, from flat to nearly conical. All the cores are bifacial or partly bifacial and there are no polyhedral cores with multifacial flaking. The total number of observable flake scars does not exceed 10 for both the faces (except for one core with 13 scars); the average is 7.3 scars per core that may be quite close to the number of flakes obtained from each core, since none of them seem to have been intensively exploited. The scar pattern is mostly unidirectional, but sometimes also bi-directional or crossed (multidirectional but not properly convergent). It is to be noted that both the faces are unequally exploited; on some of the cores, the less exploited face just shows a few isolated flake scars, used as platform for striking flakes from the other face. This suggests that both faces do not play the same role in the core reduction process. But this organisation is not general and it also happens, especially when the number of flake removals increases, that the less exploited, more cortical and more convex face bears the last removal/removals, the more productive face being then taken as the striking platform. Sometimes the cortex (neocortex resulting from river wearing) is simply used as the striking platform; this is rare for the visible removals but it might have been the rule for the first one(s).

According to the degree of exploitation and the convexity of each face, these cores have different morphologies, from chopper like cores to almost discoidal cores (fig. 3). The concept of core reduction recalls that of chopper trimming: flaking from the edge towards the centre by striking on a preliminary removal or sometimes directly on the cortex, and proceeding that way along the periphery, on a small or longer stretch but rarely on the total periphery.

Some of these cores may be confused with bifacial choppers (chopping tools), but since their edge, formed by the flake removals, is not regularised by retouching, they are considered to be cores. However they may show, as some of the other cores in this assemblage, chipping of the edges (5/13) or crushing marks (1/13) or both (1/13), suggesting they were utilised as tools (these marks probably do not result from natural agents, since the artefacts are imbedded in sand or fine gravel).

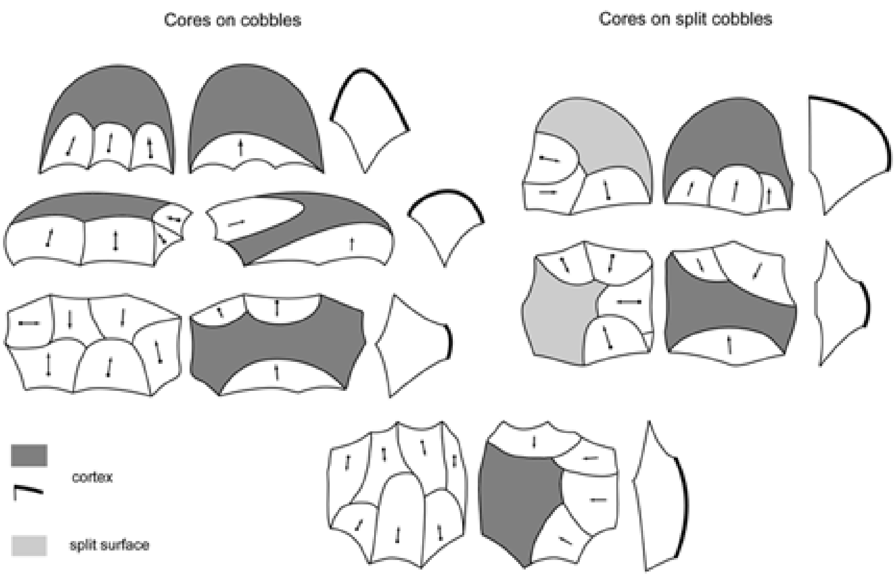

Figure 3. Schematic core reduction sequence at Atbarapur

4.3. Reconstruction of the processing sequence

Within the assemblage recovered from Atbarapur, the flakes are in average bigger than the cores (table 2). Therefore the former do not result from the reduction of the latter, or they only represent the first stage of their reduction sequence, when the products are of the largest size. But in the assemblage from Atbarapur, there is neither any exhausted core nor any core showing intensive exploitation, possibly deriving from a big core having previously provided large flakes. Moreover, the study of the cores shows that all of them were probably cobbles at the beginning of the reduction sequence and already smaller than the large flakes. Therefore these flakes cannot correspond to the first stage of exploitation of the cores from Atbarapur. They were definitely produced from other larger cores.

Meanwhile the method of flaking is quite similar for both types of production. The analysis of the flakes suggests 6 or 7 products for each boulder or cobble core and the studied cores shows an average of 7 scars, involving an average production of 7 to 9 flakes. The flaking directions are, both on flakes and cores, mostly unidirectional, sometimes perpendicular or crossed. There is neither preparation of the striking platforms nor of the flaked surfaces and this is clearly visible on both the flakes and the cores. The Kombewa method proper might have been used but the flakes with two "ventral faces" may also have been struck from the nearly flat face of split boulders. Actually no Kombewa cores are clearly identifiable in the assemblage, while split cobbles are well represented; if the same core reduction method was applied, right from the beginning, to both large and small productions, splitting might have been applied to the boulders, except if their bigger size makes it much more difficult than for the cobbles.

Therefore it seems that the large and small flakes were both produced at the original site and, right from the beginning, the cores were selected according to the desired size of the flakes that were to be produced (or inversely). Both groups of cores were processed in the same way, following a simple and short sequence (mostly less than ten flakes per core; fig. 3).

5. Trimming of the tools

5.1. Handaxes

Among the 15 handaxes, 11 are proper handaxes (2 of them being broken near the tip), 2 are partial handaxes, bifacially retouched on one side only, one is atypical, retouched on the margins only, and one is strictly unifacial, oval in shape, resembling a small "sumatralith" (typical Hoabinhian tool in South-East Asia).

All these handaxes are made on flakes, except one that is possibly made on a small slab, if not on a flake, and one whose blank is undetermined and without any cortex. Therefore none of these tools were made directly from cobbles. When the flakes used as blanks still keep their striking platform or some technological orientation mark, they appear as side struck flakes more often (6/13) than end struck flakes (2/13), but undetermined flakes are not negligible (5/13). Only 4 striking platforms are preserved (others are removed by retouch): 3 are cortical and one is without cortex. When visible, the percussion point is more often at an angle (4/13) than in the middle (2/13). The dorsal face is variable: it is either without cortex (5/13) or with very little cortex (usually on a back; 2/13), but is also entirely cortical (3/13) or partly cortical (3/13). It is to be noted that unlike the cleavers no Kombewa flake is identifiable among the handaxes.

The extent of the flake scars trimming the blanks into handaxes never covers the entire face, except for one of these tools, which is at the limit between handaxe and core, and shows a face entirely covered by flake scars. Apart from it, trimming generally extends on about half of each face, slightly more on the ventral face than on the dorsal face (table 5). Usually 2 generations of retouch can be observed (8/15), the second one regularising the edge shaped by the first one. A few handaxes (4/15) are trimmed by one generation of flaking only; some other ones (3/15) are more carefully worked and show 3 generations of flake scars.

Ventral face	Dorsal face						TOTAL
	0	**< 1/4**	**1/4 to 1/2**	**1/2 to 3/4**	**> 3/4**	**Entire**	
< 1/4		1					1
1/4 to 1/2			2	1	1		4
1/2 to 3/4			4	2		1	7
> 3/4	1		1		1		3
TOTAL	1	1	7	3	2	1	15

Table 5 – Extension of the trimming on each face of the hand-axes from Atbarapur

The overall shape of the handaxes from Atbarapur is either amygdaloid (6/15) or oval (6/15), except for 1 handaxe-cleaver having a trapezoidal shape (and 2 broken specimens).

It is to be noted that none of them is properly pointed. All the tips are more or less rounded (7/15) or they are cutting edges (2/15) or short steep edges (2/15), the other three being broken. Some of these tips are even not trimmed (5/15). When trimmed, the retouch is rather unifacial (3 inverse, 2 direct) than bifacial (2/15). But use marks are very common in the form of chipping, either on both faces (6/15) or only one face (ventral 3/15, dorsal 1/15). One of the tips also bears a crushing mark.

The butt of the handaxes is unworked for half of them (5/15) and otherwise it is trimmed by unifacial inverse (5/15) or bifacial (3/15) retouch; two specimens have no butt as they are broken. The shape of the butt is usually a steep back either cortical (4/15) or non cortical (3/15); it can be trimmed into a thick cutting edge or bevel (2 cortical with inverse retouch, 2 non cortical with bifacial retouch) or a sharp cutting edge (1 with bifacial retouch) or even be pointed (the handaxe-core). The butts seem to have been utilised too, as they show some chipping either on both faces (2/13) or on the ventral face (3/13) or dorsal face (1/13); crushing marks occur on one of the unretouched steep cortical butts.

Most of the lateral edges of the handaxes are not sharp and instead of cutting edges they are named "bevels" (angle between *ca.* 55° and 80°); only 2 specimens have sharper edges. They are usually bifacially trimmed on both sides (11/15) but 3 of them have only one bifacial edge, the opposite one being unifacially worked, and, as mentioned above, one is strictly unifacial.

The handaxes from Atbarapur (fig. 4) are made on large flakes, which are not much modified by the flaking which hardly covers more than half of each face. Therefore these tools result from a limited work and the points are not especially trimmed: they appear to be just the continuation and junction of the edges. If the chipping of the edges results from utilisation, it suggests that these tools were utilised in many ways since it occurs on different parts of the edges, preferentially on the cutting edges but also on the backs (steep edges), whatever their location is (lateral sides, tips or butts).

5.2. Cleavers

The cleavers (fig. 5) represent the most important component of this assemblage and it is worth noting that they more than double the number of handaxes. Almost all of them (32/37) are made on side struck flakes, only a few being on end struck flakes (3/37) or undetermined flake (1/37); one is on a split cobble. Striking platforms are as often cortical (9/36) as non cortical (10/36); dihedral platforms are quite common (6 without cortex and 1 partly cortical) and there is one linear cortical platform (stroke applied on a ridge of the core). The others are removed by trimming. The percussion point is mainly in the middle (18/36), otherwise it is at an angle of the flaking face (8/36) or in between (6/36). The dorsal faces of

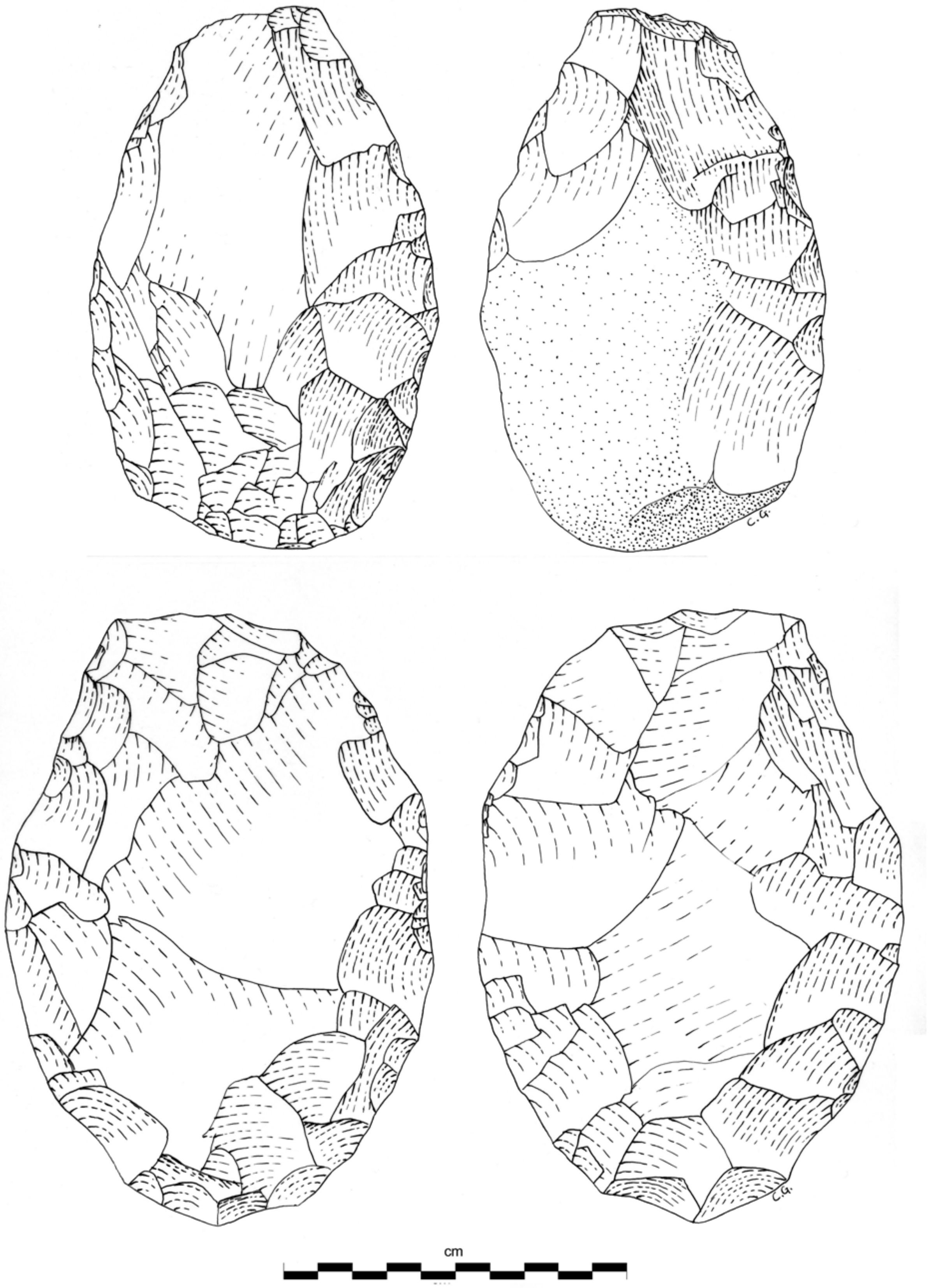

Figure 4. Handaxes from Atbarapur

the blank flakes are often entirely cortical (14 including the split cobble), providing cleavers classified as "type 0" (Tixier 1958). But most of the blanks are without cortex (13/37) or with a small cortical patch, often as a steep edge/back (10/37). Among the latter, the Kombewa flakes or flakes from split boulders are the majority (12) either without cortex (7) or with a cortical back (5). As mentioned above, the Kombewa flakes are absent in the handaxe group. Actually such flakes usually offer a sharp cutting edge on a greater part of their periphery and they are ideal for making cleavers, whereas they do not fit the pattern of handaxes.

The cleavers are usually trimmed on the margins only; however the retouch can extend up to half of each face and sometimes extends even further, especially on the ventral face (table 6). This may be related to the thinning of the bulb. For half of the cleavers (18/37) the trimming consists of just one generation of retouch, without further regularisation of the edges (which are not supposed to be working edges). The other ones show 2 generations of retouch (15/37) and rarely more (4/37). Therefore, the original shape of the blank flakes is hardly modified. The outlines are mostly trapezoidal (14/37) or rectangular (9/37) or oval (7/37).

Ventral face	**Dorsal face**					
	0	**< 1/4**	**1/4 to 1/2**	**1/2 to 3/4**	**> 3/4**	**TOTAL**
0		2	1	1		4
< 1/4		3	5	3		11
1/4 to 1/2	2	4	2		2	10
1/2 to 3/4	1	3	5	1	1	11
> 3/4		1				1
TOTAL	3	13	3	5	3	37

Table 6 - Extension of the trimming on each face of the cleavers from Atbarapur

By definition, the cleavers are characterised by a cutting edge that is unretouched. It is supposed to be the main functional part of the tool, but the other edges may be utilised too. At Atbarapur the cleaver edges are all slightly convex and most of the time both their faces are devoid of cortex (26/37); but there are also a good number of cleavers whose cutting edge is along a cortical dorsal face (11/37). The location of the cutting edge, relatively to the technical orientation of the blank flake, is more often on the left side (22/37) than on the right side (9/37), while the other ones (6/37) are on the transversal edge. Even though the difference between left and right appears quite high, it is not significantly deviant from an even distribution, according to the chi-square test (chi-square = 1.74 < 3.84 for d.f. = 1 and 0.05 level of significance).

Utilisation is suggested by chipping of the edge, either on both the faces (16/37) or on one face only and in that case the ventral face is more often damaged than the dorsal face (10 and 4 respectively, no chipping being observed on the cortex along the edges). There are a few edges without use marks (7/37).

The butt opposite to the cutting edge is a bevel (open angle edge) in most of the cases, otherwise it is a steep edge (or back) and rarely a cutting edge. These different butt morphologies, from steep to sharp, are either cortical or non cortical, and trimmed or untrimmed (table 7). The cleaver butts are sometimes damaged (= used?) what ever their form is, but provided they are devoid of cortex (except one butt that is a cortical cutting edge). These marks take the form of chipping (8 bifacial, 4 direct, 4 inverse) or crushing (2). It seems there is no link between the damage of the cleaver cutting edge and that of the butt. Anyway, if these damages are due to utilisation, they show that the sharp cutting edge of the cleavers is not the exclusively active part of these tools.

Morphology	Trimming				TOTAL
	bifacial	direct/up	inverse/down	nul	
back, cortex	1	3		3	7
back, no cortex	4		2	1	7
bevel cortex			2	3	5
bevel no cortex	8	3	1		12
cutting edge cortex	1		1		2
cutting edge no cortex	1	1		2	4
TOTAL	15	7	6	9	37

Table 7 – Relation between morphology and trimming of the cleavers butt from Atbarapur

All the lateral sides of the cleavers are trimmed, except 4 (1 on the left side and 3 on the right side). This trimming is independent of the original morphology of the sides and does not modify them much. Most of the sides are either steep, making a back (all together, 26/74 without cortex, 4/74 cortical) or oblique, making a bevel (22/74 without cortex, 6/74 cortical); they are rarely sharp (6 and 3/74). The trimming is bifacial for half of them (38/74; table 8) but only 13 cleavers show bifacial trimming of both their sides.

Morphology	Trimming				TOTAL
	bifacial	direct/up	inverse/down	nul	
back, cortex		3	1		4
back, no cortex	14	3	8	1	26
bevel cortex		1	4	1	6
bevel no cortex	15	5	2		22
cutting edge cortex	1	1	1		3
cutting edge no cortex	5			1	5
miscellaneous	3	3		1	7
TOTAL	38	16	16	4	74

Table 8 - Relation between morphology and trimming of the lateral sides of the cleavers from Atbarapur

Damages are quite common on the lateral sides of the cleavers, especially chipping (only 3 crushing marks). They occur on both sides (13/37) or on one side only (10/37); but some specimens do not show any (14/37). The lateral and proximal sides appear to have been damaged whatever their shape is.

5.3. Choppers

The question often arises of whether the choppers are implements or cores. As already mentioned regarding the cores, the regularity of the edge helps in distinguishing between the two. In the assemblage from Atbarapur, 13 choppers were identified and among them 6 are made on flakes and 5 on cobbles. Some of these cobbles may be preliminary broken. As for the flakes, all are side struck except one; they mostly have a cortical platform (4/6) and their dorsal face is either entirely cortical (3) or partly cortical (1) or with a cortical back only (1 Kombewa flake) or without cortex (1). Therefore, half of the choppers are made on blanks that show the same technical characteristics the cleavers.

Trimming of the choppers is mostly unifacial (8/13) but on a few of them this unifacial trimming changes its direction at places, upwards/downwards (2/13). Strictly bifacial trimming (chopping tool) is rare (3/13). In half of the cases (7/13), the trimming results from one generation (one series) of retouches, and for the other ones a second generation of retouches makes the edge more regular and even. On the unifacial choppers, the trimming

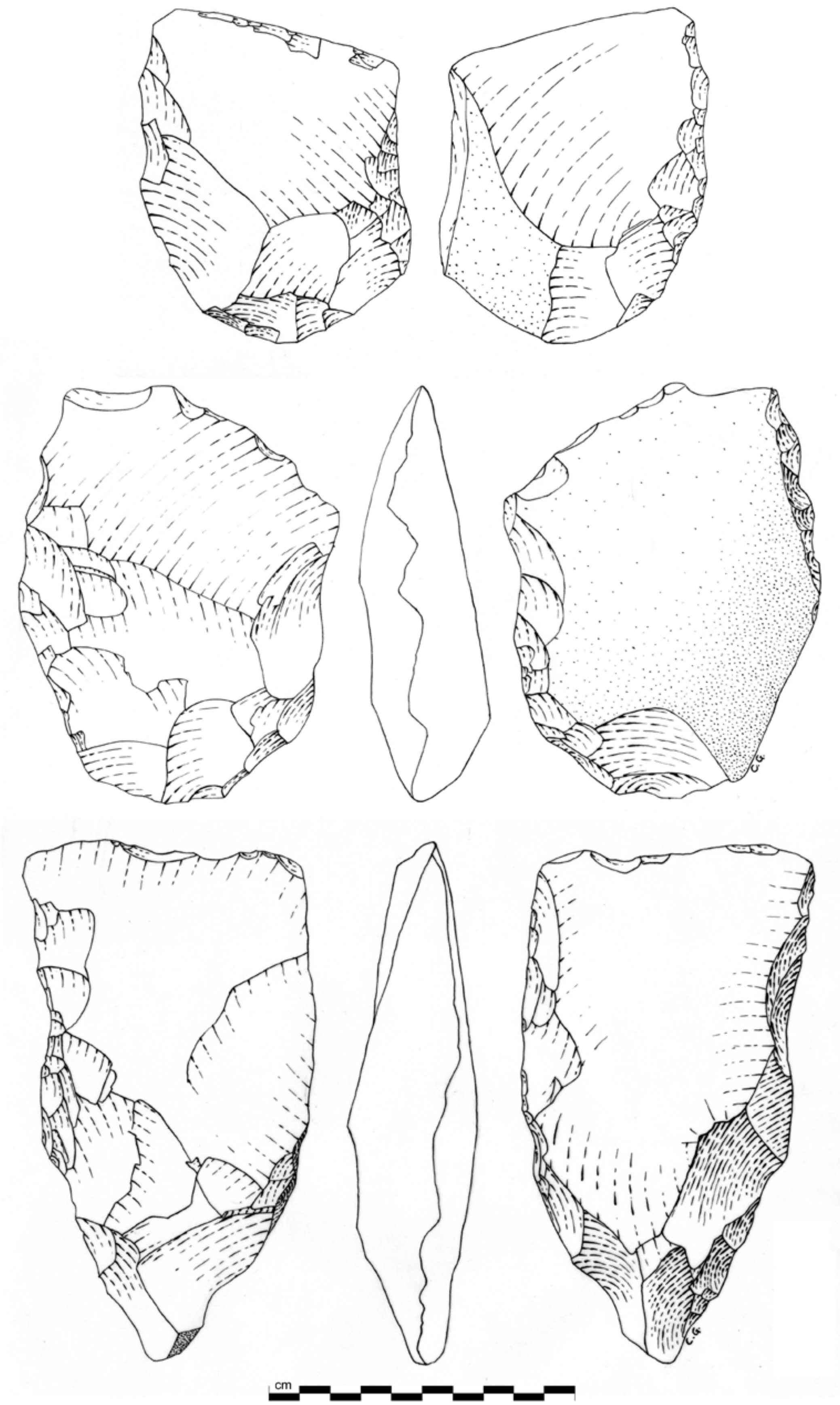

Figure 5. Cleavers from Atbarapur

sometimes spreads on more than half of the face area (5/8), but on the bifacial ones, this happens only when the other face shows a minimal trimming, less than 1/4 (2/5). The pitch of the choppers edges varies widely from cutting to steep.

6. Conclusion

Although it is not in a primary situation, the assemblage from Atbarapur includes a set of artefacts which, altogether, are very informative regarding the technical behaviour of the Acheulian people having made and used them. It is composed of large flakes (nearly 140 mm long in average) on the one hand, and cores and choppers on the other hand, both having almost the same size. They correspond to two parallel reduction sequences, following the same modalities, but one uses boulders as cores (absent at the site) and the other one uses cobbles (from which the flake products are missing). Apart from the cores and half of the choppers, the whole assemblage is made on flakes, the majority of them being trimmed into cleavers and handaxes.

These features are very significant in the context of the Siwaliks, where most of the sites yield Soanian assemblages, composed of choppers and a few cores on cobbles, as well as flakes resulting from their shaping or exploitation. There are no handaxes or cleavers, and large flakes are usually absent in the Soanian assemblages.

The production of large flakes seems to be an important character of the Acheulian technical tradition or "Mode 2", throughout the world. In India, such large flakes may be obtained from various types of materials, occurring in different ways. It may be quartzite quarried from the outcrops, close to the site, as in the shelter IIIF-23 at Bhimbetka (Misra 1985), or silicified limestone quarried at the site itself, as in Isampur (Paddayya *et al*. 1997, 1998, 2006); it may be basalt flaked from boulder sized nodules (resulting from spheroidal weathering), as in Morgaon (Maharashtra; Mishra *et al.* in press) or dyke basalt flaked from blocks of the weathering outcrop as in Chirki on the Pravara (Corvinus 1983), or quartzite from boulders and cobbles, as in Atbarapur, or in the Narmada valley, or also in Attirampakam (Tamil Nadu; Pappu 2001, Pappu and Akhilesh 2006) as well as in many sites in peninsular India.

Anyway, the lack of boulders or large blocks, hence of large flakes, never hinders the prehistoric craftsmen from making handaxes, while cleavers become difficult to produce. Actually many Acheulian assemblages comprise handaxes on cobbles or nodules. The most significant example is that of all the Lower Palaeolithic sites in the Somme-Seine-Thames basin (including Saint-Acheul) in north-western Europe, where the handaxes are made from flint nodules and where the cleavers proper (on flakes) are absent (yet some handaxe-cleavers show morphological convergence with cleavers but are obtained with a different shaping method). In Peninsular India, many sites yield handaxes on nodules, like Bori (Maharashtra; Mishra *et al.* 1995), Renigunta (Andhra Pardesh; Gaillard and Murty 1988, Gaillard *et al*. 1990), or on slabs, like Singi Talav at Didwana (Rajasthan; Gaillard *et al.* 1983, 1985, 1986). Actually the large diversity of Acheulian assemblages may be linked to the variety of the raw materials, in nature and shape. However this diversity does not go beyond a certain limit an even from a diversified raw materials, the Acheulian tool makers could produce rather standardised implements (Sharon 2008).

Considering the geographical situation of Atbarapur, between the Indo-Gangetic plain and the Himalayan range, it would be very interesting to find in this site some indication related to the possible diffusion routes of the Acheulian from Africa to East and Southeast

Asia, if at all the Acheulian phenomenon is a matter of diffusion and not a matter of polycentric inventions (as suggested by Boëda 2005). In the most common hypothesis of cultural and technical diffusion, or even migration of people bearing the Acheulian tradition, the coastal plains would have been the easiest way, either through the Arabic peninsula, by crossing the Bab el Mandab and Ormuz straights (Petraglia 2003, 2005), or through the Levantine corridor, where Acheulian sites are well represented at early dates, as for instance Ubeidiya (Bar-Yosef and Goren-Inbar 1993) and Gesher Benot Ya'aqov (Goren-Inbar *et al*. 2000). But another route, in slightly higher latitudes and altitudes, might have been a good alternative, as further east the upland environment seems to be quite favourable to human occupations (Schepartz *et al*. 2000). However it should be borne in mind that at the time when Acheulian people where living in the region of Atbarapur, *i.e.* before the post-Siwalik tectonic phase, the local landscape was very different, since the Siwalik hills did not exist. They occupied the sector, at least from the Jhelum valley (sites of Dina and Jalalpur, Rendell & Dennell 1985) to the Nepal (sites of Gadari and Satpati, Corvinus 1990, 1995b, 2007) and they left single artefacts at many places along the Siwaliks of North-Western India (Singh in press). Lack of link evidences with the West (Levant) and the East (Bose basin in China) may just be the result of less research in the field and it is not sufficient for supporting the absence of cultural/technical continuity. The Acheulian large cutting tools from Atbarapur, mainly made on large flakes, compare well with those from GBY and from many sites in Africa (Sharon 2007), but they differ significantly, as far as the tool blanks are concerned, from those found in the Bose basin, which nonetheless have a lot of similarities with any Acheulian assemblage mainly made from cobbles (Xie and Bodin 2007). In any case, more sites are needed for implementing the discussion regarding the dispersal, diffusion or polycentrism of the Acheulian.

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References

Bar-Yosef, O. and N. Goren-Inbar 1993. *The lithic assemblages of 'Ubeidiya*, Qedem 34, The Hebrew University of Jerusalem, 266 p.

Blackwell, B.A.B., S. Fevrier, J.I.B. Blickstein, K. Paddayya, M. Petraglia, R. Jhaldiyal and A.R. Sinner 2001. ESR dating of an Acheulean quarry site at Isampur, India, *Journal of human Evolution* 40 (2001), Absracts for the Paleoanthropology Society Meetings: A3.

Boëda E. 2005. Paléo-technologie ou anthropologie des techniques ? *Arob@se,* www.univ-rouen.fr/arobase, 1, 46-64.

Chauhan, P. 2003. An overview of the Siwalik Acheulian and reconsidering its chronological relationship with the Soanian – A theoretical perspective. *Assemblage - the Sheffield graduate journal of archaeology*, 7 (on line).

Corvinus G. 1983. A survey of the Pravara River system in western Maharashtra, India, vol. 2: *The Excavation of the Acheulian Site of Chirki-on-Pravara, India*. Tübingen: Archaeologica Vanatoria, Tübinger Monographien zur Urgeschichte 2, 466 p.

Corvinus, G. 1990. A Note on the Discovery of Handaxes in Nepal. *Man and Environment* 15(2): 9-11.

Corvinus, G. 1991, A handaxe assemblage from western Nepal. Quartär 41/42: 155-173.

Corvinus, G. 1995a. Quaternary Stratigraphy of the Intermontane Dun Valleys of Dang-Deokhuri and Associated Prehistoric Settlements in Western Nepal. in *Quaternary Environment and Geoarchaeology of India* (S. Wadia, R. Korrisettar and V.S. Kale Eds.), Geolgoical Society of India Memoir 32, Bangalore, pp. 150-167.

Corvinus, G. 1995b. The Satpati Handaxe site and the Chabeni Uniface Site in Southern Nepal. *Quartär* 45/46: 15-36.

Corvinus, G. 2004. Homo erectus in East and Southeast Asia, and the questions of the age of the species and its association with stone artifacts, with special attention to handaxe-like tools. *Quaternary International*, 117: 141-151.

Corvinus, G. 2007. *Prehistoric cultures in Nepal*. Harrassowitz Verlag Wiesbaden, vol. 1: 383 p., vol. 2 (ill.): 263 p.

Forestier, H., H.T. Simanjuntak and D. Drivantono 2005. Les premiers indices d'un faciès acheuléen à Sumatra Sud, *Dossiers d'Archéologie* 203 (Avril 2005): 16-17.

Gaillard, C., D.R. Raju, V.N. Misra and S.N. Rajaguru 1983. Acheulian Occupation at Singi Talav in the Thar Desert: A Preliminary Report on 1982 excavation. *Man and Environment* 7: 112-130.

Gaillard, C., V.N. Misra and S.N. Rajaguru 1985. Acheulian Occupation at Singi Talav in the Thar desert: A Preliminary Report on the 1981 Excavation. *Bulletin of the Deccan College Post-Graduate & Research Institute* 44: 141-152.

Gaillard, C., D.R. Raju, V.N. Misra and S.N. Rajaguru 1986. Handaxe Assemblages from the Didwana Region, Thar Desert, India: A Metrical Analysis. *Proceedings of the Prehistoric Society* 52: 189-214.

Gaillard, C. and S. Mishra 2001. The Lower Palaeolithic in South Asia, in *Origine des peuplements et chronologie des cultures paléolithiques dans le Sud-Est Asiatique* (F. Semah, Ch. Falguères, D. Grimaud-Hervé, A.-M. Semah Eds.) pp. 73-91. Paris: Semenanjung-Artcom.

Gaillard, C., V.N. Misra and M.L.K. Murty 1990. Comparative study of three series of handaxes: one from Rajasthan and two from Andhra Pradesh. *Bull. of the Deccan College Research Institute* 49: 137-143.

Gaillard, C. and M.L.K. Murty 1988. Typo-technological comparison of two Acheulian assemblages at Renigunta, South India. *Man and Environment* 12: 123-133.

Geological Survey of India (GSI) 1976. *Publication for the 125th anniversary celebrations*. Hoshiarpur, Punjab region.

Goren-Inbar, N., C.S. Feibel, K.L. Verosub, Y. Melamed, M.E. Kislev, E. Tchernov and I. Saragusti 2000. Pleistocene milestones on the Out-of-Africa corridor at Gesher Benot Ya'aquov, Israel. *Science* 289(5481): 944-947.

Hou, Y., R. Potts, B. Yuan, Z. Guo, A. Deino, W. Wang, J. Clark, G. Xie and W. Huang 2000. Mid-Pleistocene Acheulean-like Stone Technology of the Bose Basin, South China. *Science* 287: 1622-1626.

Huang, W.W. 1989. Bifaces in China. *Human Evolution* 4: 87-92.

Keates, S.G., 2002. The Movius Line: fact or fiction? *Bulletin of the Indo-Pacific Prehistory Association* 22, 17-24.

Koenigswald G.H.R. Von 1936. Early Palaeolithic stone implements from Java. *Bulletin of Raffles Museum* (Singapore) 1: 52-60.

Kumar, M. and K.K. Rishi 1986. Acheulian elements from Hoshiharpur region (Punjab). *Man and Environment* 10: 141-142.

Lal, B.B. 1956. Palaeoliths from the Beas and Banganga Valley, Punjab, *Ancient India* 12: 58-92.

Lumley H. de, F. Sémah et H.T. Simanjuntak 1993. Les outils du Pithécanthrope. *Les Dossiers d'Archéologie*, 183 (Le Pithécanthrope de Java): 62-67.

Mishra S., S. Deo, R. Abbas, S. Naik, G. Shete, N. Agrawal and S. N. Rajaguru in press. The Early Acheulian Site of Morgaon, District Pune, 2000-2007, *Deccan College bulletin, Sankalia commemoration volume*

Mishra, S., T.R. Venkatesan, S.N. Rajaguru and B.L.K. Somayajulu 1995. Earliest Acheulian Industry from Peninsular India. *Current Anthropology* 36: 847-851.

Misra V.N. 1985. The Acheulian succession at Bhimbetka, Central India. in *Recent advances in Indo-Pacific prehistory* (V.N. Misra and P. Bellwood eds.) pp. 35-47. Oxford and IBH Publishing Co.

Mohapatra, G.C. 1966. Preliminary Report of the Exploration an Excavation of the Stone Age Sites in Eastern Punjab. *Bulletin of the Deccan College Research Institute* 25: 221-237.

Mohapatra, G.C. 1975. Acheulian element in Soanian culture area. *Journal of the Archaeological Society of Nippon,* Japan 6(4): 4-18.

Mohapatra, G.C. 1981. Acheulian Discoveries in the Siwalik Frontal Range. *Current Anthropology,* 22(4): 433-435.

Mohapatra, G.C. and M. Singh 1979a. Prehistoric investigations in a sub-himalayan valley, Himachal Pradesh, India. *Current Anthropology* 20 (3): 600-602.

Mohapatra, G.C. and M. Singh 1979b. Stratified Occurrence of Lithic Artifacts in the Siwalik frontal Range of Western Sub-Himalaya. *Punjab University Research Bulletin* 10 (1-2): 65-77.

Movius H.L. 1944. Early man and Pleistocene stratigraphy in Southern and Eastern Asia. *Papers of the Peabody Museum* 19(3) 125 p.

Movius H.L. 1948. The Lower Palaeolithic cultures of Southern and Eastern Asia. *Transactions of the American Philosophical Society* 38(4): 329-420.

Nanda, A.C., 2002. Upper Siwalik mammalian faunas of India and associated events. *Journal of Asian Earth Sciences* 21: 47-58.

Norton C. J., K. Bae, J. W.K. Harris and H. Lee 2006. Middle Pleistocene handaxes from the Korean Peninsula. *Journal of Human Evolution*, 51: 527-536.

Opdyke, N.D., E. Lindsey, G.D. Johnson, R.A.K Tahir Kheli and M.A. Mirza 1979. Magnetic polarity stratigraph and vertebrate palaeontology of the Upper Siwalik subgroup of northern Pakistan. *Palaeogeography, Palaeoclimatology, Palaeoecology* 27: 1-34.

Paddayya, K., B.A.B. Blackwell, R. Jhaldiyal, M.D. Petraglia, S. Fevrier, D.A. Chaderton II, J.I.B. Blickstein and A.R. Skinner 2002. Recent findings on the Acheulian of the Hunsgi and Baichabl valleys, Karnataka, with special reference to the Isampur excavation and its dating, *Current Science* (Bangalore) 83(5): 641-647.

Paddayya, K., R. Jhaldiyal and M.D. Petraglia 2006. The Acheulian quarry at Isampur, Lower Deccan, India. in *Axe Age - Acheulian Tool-making from Quarry to Discard* (N. Goren-Inbar and G. Sharon eds.) pp. 45-74. London, Oakville: Equinox Publishing Ltd.

Paddayya, K. and M.D. Petraglia 1997. Isampur: an Acheulian workshop site in the Hunsgi valley, Gulbarga district, Karnataka. *Man and Environment* 22 (2): 95–110.

Paddayya, K., M.D. Petraglia 1998. Acheulian workshop at Isampur, Hunsgi valley, Karnataka: a preliminary report. *Bulletin of the Deccan College Research Institute* 56–57: 3–26.

Pappu, S., 2001. *A Re-examination of the Palaeolithic Archaeological Record of Northern Tamil Nadu, South India*. Oxford: British Archaeological Reports International Series 1003, 246 p.

Pappu, S. and K. Akhilesh 2006. Preliminary observations on the Acheulian assemblages from Attirampakkam, Tamil Nadu. in *Axe Age - Acheulian Tool-making from Quarry to Discard* (N. Goren-Inbar and G. Sharon eds.) pp. 155-180. London, Oakville: Equinox Publishing Ltd.

Petraglia, M.D. 2003. The Lower Paleolithic of the Arabian Peninsula: occupations, adaptations, and dispersals. *Journal of World Prehistory* 17: 141-179.

Petraglia, M.D., 2005. Hominin responses to Pleistocene environmental change in Arabia and South Asia, *Geological Society, London, Special Publications*, 247, 305-319.

Pruffer, O. 1956. Prehistory of the Sirsa Valley, Punjab, India. *Quartär* 7-8: 91-123.

Rendell, H. and R.W. Dennell 1985. Dated Lower Palaeolithic artefacts from Northern Paksitan. *Current Anthropology* 26(5): 393-394.

Rishi, K.K., 1989. *Palaeoliths from Atbarapur, Punjab*. Department of Cultural Affairs, Archaeology and Museums, Punjab, 60 p.

Sangode, S., S. Mishra, S. Naik and S. Deo 2007. Magnetostratigraphy of the Quaternary sediments associated with some Toba Tephra and Acheulian artefact bearing localities in the Western and Central India. *Gondwana Magazine, special volume* 10: 111-121.

Sémah, F., A.-M. Sémah, T. Simanjuntak 2003. More than a million years of human occupation in insular Southeast Asia: the early archaeology of eastern and central Java. in *Under the Canopy: The Archaeology of Tropical Rain Forests* (J. Mercader ed.) pp. 161-190. New Brunswick: Rutgers University Press.

Sen, D. 1955. Nalagarh palaeolithic culture. *Man in India* 35(3): 176-183.

Sharon, G. 2007. *Acheulian Large flake industries: technology, chronology and significance*. BAR International Series 1701, Oxford: Archaeopress, 236 p.

Sharon, G., 2008. The impact of raw material on Acheulian large flake production, *Journal of Archaeological Science* 35: 1329-1344.

Schepartz, L.A., S. Miller-Antonio and D.A. Bakken 2000. Upland resources and the early Palaeolithic occupation of Southern China, Vietnam, Laos, Thailand and Burma, *World Archaeology* 32 (1): 1-13.

Singh, M., in press. Acheulian in the Siwaliks of North-Western India. *Proceedings of the international conference on "Les cultures à bifaces du Pléistocène inférieur et moyen dans le monde. Émergence du sens de l'harmonie"*, Tautavel 25-30 juillet 2007.

Singh, M., B.S. Karir and S.N. Chopra 1998. *Prehistoric and Quaternary Studies of the Roop Nagar District of Punjab,* Research project sponsored by the Government of Punjab, Department of Cultural Affairs, Archaeology & Museums, Chandigarh, 265 p. (unpublished manuscript).

Teilhard de Chardin, P. and H. De Terra 1936. Observations on the upper Siwalik formation and later Pleistocene deposits in India. *Proceeding of the American Philosophical Society*, 76 (6): 791-822.

Teilhard de Chardin, P. 1936. Joint geological and prehistoric studies in the late Cenozoic in India. *Science* 83(2149): 233-236.

Teilhard de Chardin, P. 1935, 1936. in *Teilhard de Chardin en Chine, correspondance inédite [1923 - 1940]* (A. Vialet et A. Hurel eds.), 2004. Les Editions du Muséum - Edisud, 287 p.

Terra, H. de and T.T. Paterson 1939. *Studies on the Ice Age in India and associated human cultures*. Washington: Carnegie Institute Publication, 493.

Tixier J., 1958. Le hachereau dans l'Acheuléen nord-africain. Notes typologiques. in *Congrès préhistorique de France, compte-rendu de la 15ème session (Poitiers-Angoulême 1956*) pp. 914-923.

Xie, G.M. and E. Bodin 2007. Les industries paléolithiques du bassin de Bose (Chine du Sud), *L'Anthropologie* 111: 182-206.